

This is a repository copy of *Sequential Data Mining using Correlation Matrix Memory*.

White Rose Research Online URL for this paper:

<https://eprints.whiterose.ac.uk/67996/>

Version: Published Version

---

**Proceedings Paper:**

Shanker, Sanil, Turner, Aaron, Sherly, Elizabeth et al. (1 more author) (2010) Sequential Data Mining using Correlation Matrix Memory. In: Proceedings. ICNIT 2010 International Conference on Networking and Information Technology. Proceedings. ICNIT 2010 International Conference on Networking and Information Technology, 11-12 Jun 2010 IEEE , PHL , pp. 470-472.

<https://doi.org/10.1109/ICNIT.2010.5508469>

---

**Reuse**

Items deposited in White Rose Research Online are protected by copyright, with all rights reserved unless indicated otherwise. They may be downloaded and/or printed for private study, or other acts as permitted by national copyright laws. The publisher or other rights holders may allow further reproduction and re-use of the full text version. This is indicated by the licence information on the White Rose Research Online record for the item.

**Takedown**

If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing [eprints@whiterose.ac.uk](mailto:eprints@whiterose.ac.uk) including the URL of the record and the reason for the withdrawal request.

# Sequential Data Mining using Correlation Matrix Memory

Sanil Shanker KP

Department of Computer Science, University of Kerala,  
India  
e-mail: sanilshankerkp@gmail.com

Aaron Turner

Department of Computer Science, University of Kerala,  
India

Elizabeth Sherly

Indian Institute of Information Technology and  
Management- Kerala, India

Jim Austin

University of York, UK

**Abstract:** This paper proposes a method for sequential data mining using correlation matrix memory. Here, we use the concept of the Logical Match to mine the indices of the sequential pattern. We demonstrate the uniqueness of the method with both the artificial and the real datum taken from NCBI databank.

**Keywords:** Correlation matrix memory, Logical Match, Sequential data mining.

## I INTRODUCTION

In this paper we put forward a unique method of search for sequential patterns using correlation matrix memory by Logical Match. The correlation matrix memory is a particular type of binary associative neural network (Austin,1994). In Logical Matching strategy, the sequence is arranged so that each element in the pattern coincides with it's corresponding index and then proceed to match logically the indices of the subsequence with those of the text pattern (Sanil et al,2010). A correlation matrix memory can be represented as a  $m \times n$  binary matrix  $D$ , where  $m$  and  $n$  are input width and output width respectively. For a given sequential pattern the input binary vector  $I_{SP}$  operates logical AND with reference matrix (database  $D$ ) gives  $I_{SP}^T$ . During the transformation,  $O_p \leftarrow I_p \cdot D$ , we mine the indices of both the pattern and text using logical matching, where  $I_{SP}^T = O_{SP}$ , the output binary vector of the sequential pattern.

## II METHOD

1. Initialize Text and Pattern
2. Initialize input binary vector  $I_p \leftarrow$  Pattern and  $I_T \leftarrow$  Text
3. Create the reference database  $D$
4. Select (indices of Pattern) when  $O_p \leftarrow I_p \cdot D$
5. Select (indices of Text) when  $O_T \leftarrow I_T \cdot D$
6. Match (indices of Pattern) with (indices of Text) in the increasing order of indices.

## III SIMULATION WITH ARTIFICIAL DATUM

Text => <CTCACTCCTC>

Pattern => <CTC>

Initialize {0001← A, 0010← T, 0100← G, 1000← C}

Shift the Text(Table 1) so that the input binary vector  $I_{Text}$

operates logical AND with reference matrix ( Database  $D$ )

gives  $I_{Text}^T$  (Table 2).

Input Text ( $I_{Text}$ )

Database  $D$

C	T	C	A	C	T	C	C	T
C	AND	0/1	0/1	0/1	0/1			

1	0	1	0	1	0	1	1	0	1	.	0	0	0	1
0	0	0	0	0	0	0	0	0	0	.	0	0	1	0
0	1	0	0	0	1	0	0	1	0	.	0	1	0	0
0	0	0	1	0	0	0	0	0	0	.	1	0	0	0

Table 1.

↓      ↓      ↓      ↓

Table 2. Transpose of Input Text  $I_{Text}^T$       w

x      y      z

Indices	w	x	y	z
10	0	0	0	1
9	0	1	0	0

8	0	0	0	1
7	1	0	0	0
6	0	0	0	1
5	0	1	0	0
4	0	0	0	1
3	0	0	0	1
2	0	1	0	0
1	0	0	0	1

3	0	0	0	1
2	0	1	0	0
1	0	0	0	1

That is, indices of the Text, <w(7);

x(2,5,9);

z(1,3,4,6,8,10)>

Shift the Pattern (Table 3) so that the input binary vector

$I_{Pattern}$  operates logical AND with reference matrix

(Database D) gives  $I_{Pattern}^T$  (Table 4).

Input Pattern ( $I_{Pattern}$ )

Database D

C	T	C	AND	0/1	0/1
0/1	0/1				
1	0	1	.	0	0
0	0	0	.	0	0
0	1	0	.	0	1
0	0	0	.	1	0

Table 3.

↓ ↓ ↓ ↓

w x y z

Table 4. Transpose of Input Pattern  $I_{Pattern}^T$

Indices	w	x	y	z
---------	---	---	---	---

That is, indices of the pattern, <x(2);

z(1,3)>

Locating Pattern in the Text:

z: 1 3 4 6 8 10

x: 2 5 9

z: 1 3 4 6 8 10

Here, Pattern CTC is repeating in the locations (1,2,3);(4,5,6);(8,9,10) of the text.

#### IV EXPERIMENTAL RESULTS

For testing the proposed method, the program has been written in C++ language under Linux platform. The method was tested against DNA sequences of various sizes taken from NCBI databank (Table 5). The method provides the solution to problem of locating the exact position of the pattern in the text.

Table 5. Location of Pattern in Text

Kennedy disease	(16,17,18);(53,54,55);(59,60,61);(71,72,73);(101,102,103);(111,112,113);(136,137,138);(142,143,144);(153,154,155);(159,160,161);(175,176,177);(363,364,365);(372,373,374);(386,387,388);(441,442,443);(450,451,452);(463,464,465);(533,534,535);(554,555,556);(562,563,564);(663,664,665);(685,686,687);(689,690,691);(697,698,699)
Gene: AR	
Repeat motif: CAG	
Locus: NM_000044	
Range: 1-700	
Huntington disease	(33,34,35);(57,58,59);(196,197,198);(199,200,201);(202,203,204);(205,206,207);(208,209,210);(211,212,213);(214,215,216);(217,218,219);(220,221,222);(223,224,225);(226,227,228);(229,230,231);(232,233,234);(235,236,237);(238,239,240);(241,242,243);(244,245,246);(247,248,249);(250,251,252);(253,254,255);(256,257,258);(262,263,264);
Gene: HD	
Repeat motif: CAG	
Locus:	

NM_002111 Range: 1-510	(298,299,300);(307,308,309); (319,320,321);(325,326,327); (340,341,342);(346,347,348); (428,429,430);(487,488,489); (495,496,497);(506,507,508)
Friedreich ataxia  Gene: FRDA Repeat motif: GAA Locus: AH003505S1 Range: 1- 2465	(86,87,88);(151,152,153); (158,159,160);(232,233,234); (383,384,385);(391,392,393); (491,492,493);(508,509,510); (549,550,551);(816,817,818); (947,948,949);(1011,1012,1013 ); (1015,1016,1017);(1065,1066,1 067); (1300,1301,1302);(1304,1305,1 306); (1318,1319,1320);(1327,1328,1 329); (1345,1346,1347);(1378,1379,1 380); (1485,1486,1487);(1535,1536,1 537); (1558,1559,1560);(1601,1602,1 603); (1631,1632,1633);(1639,1640,1 641); (1649,1650,1651);(1668,1669,1 670); (1711,1712,1713);(1723,1724,1 725); (1774,1775,1776);(1781,1782,1 783); (1875,1876,1877);(1976,1977,1 978); (1979,1980,1981);(2022,2023,2 024); (2088,2089,2090);(2140,2141,2 142); (2184,2185,2186);(2187,2188,2 189); (2190,2191,2192);(2193,2194,2 195); (2196,2197,2198);(2199,2200,2 201); (2202,2203,2204);(2205,2206,2 207); (2208,2209,2210);(2217,2218,2 219); (2282,2283,2284);(2427,2428,2 429)

We present a new sequential data mining method using correlation matrix memory. Here, we use the concept of Logical Match to locate the pattern in the text. This method can possibly be implement to develop a new approach related to the sequential data mining.

#### ACKNOWLEDGEMENT

SSKP was funded in part by European Research and Educational Collaboration with Asia

#### REFERENCES

- [1] Jim Austin.(1994). Correlation Matrix Memories for Knowledge Manipulation, International Conference on Neural Networks, Fuzzy Logic and Soft Computing, Iizuka, Japan. August 17.
- [2] Sanil Shanker KP, Elizabeth Sherly, Jim Austin(2010). An Algorithm for Alignment-free Sequence Comparison using Logical Match. Proceedings of the 2nd IEEE International Conference on Computer and Automation Engineering, Singapore. Vol 3, pp 536-538.
- [3] [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov)

#### V CONCLUSION